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DISCUSSIONS

COLLOIDAL CHEMISTRY AND WATER PURIFICATION¹

If an author be permitted to discuss or supplement his own paper, I wish to submit the following:

There is a typographical error on page 580 of the paper which should read: "d. *Alkali less than tannic acid.*"

To supplement the rather involved statements under "*Color removal with aluminum sulphate,*" I wish to submit the diagram figure 1. It will be seen that in this the chemical equivalents of alkalinity, tannic acid and aluminum sulphate, are represented by distances along the z , x and y axes, and that the diagram represents a limited portion of two intersecting planes, making angles of 45° with the x and z axes. The surfaces $a c d$ and $a e d$, shown solid, are the planes of critical values, any value of aluminum sulphate which gives a point below or behind these surfaces not giving coagulation, but any values of aluminum sulphate, alkalinity and tannic acid which give a point in, above or in front of these surfaces causing coagulation. The surfaces $a b d$ and $a f e$, are the planes of complete color removal. The spaces $a b c d$ and $a f e d$ are regions of progressing coagulation and color removal. The line $a d$ represents the condition: *c. Alkali equal to tannic acid* where color removal is complete at the critical value.

Such a diagram must necessarily represent ideal conditions not met with in practice, but is useful as a skeleton framework to which actual results may be fitted, acting the usual part of the formula in applied engineering and chemistry.

It may be pointed out that where the alkalinity is in excess of the color and is composed of calcium and magnesium bicarbonates it may be reduced to the color equivalent by treatment with lime, or where less than the color, it may be increased to the color equivalent with lime or soda ash, in each case the object being to reach the condition represented by the line $a d$, which is the optimum for complete and rapid color removal.

¹ JOURNAL, November, 1921, page 571.

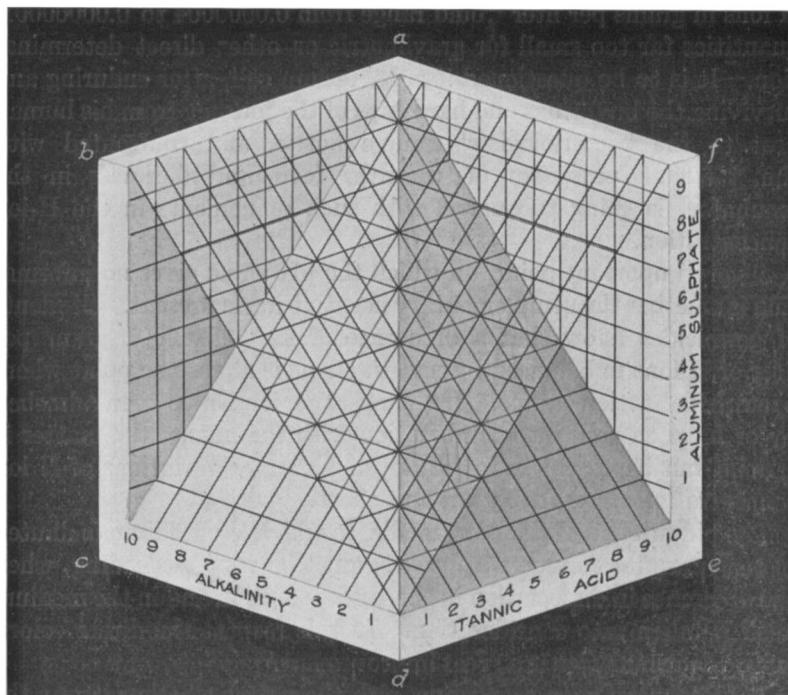


FIG. 1

The probability of soluble color which can only be removed through adsorption by the use of large quantities of coagulant was previously remarked upon by the writer.²

MILTON F. STEIN.³

THE REACTION OF CULTURE MEDIA⁴

It is well not to lose sight of the fact that the very convenient pH notation is a conventional manner for writing the negative logarithms of numbers. Thus, when the authors speak of "the wide range in the reaction of lactose broth" used in the practice of various laboratories, namely pH 6.4 to pH 8.0, this means in ordinary figures that the

² Colloids in Water and Sewage Purification, M. F. Stein, *Eng. Record*, vol. 69, no. 19, May 9, 1914.

³ Civil Engineer, Chicago, Ill.

⁴ JOURNAL, January, 1922, page 63.

H ions in grams per liter would range from 0.0000004 to 0.0000001, quantities far too small for gravimetric or other direct determination. It is to be questioned if a bacterium coli, after enduring and surviving the buffettings and hardships of the journey from his human host to the bacteriologists' sample bottle, and confronted with the pleasant prospects of warmth, food and darkness in the incubator, is going to quarrel with such refinements in the H-ion concentration.

A very important point, on which the pH value gives no information is whether the complementary negative ion is present. Students of germicides know that a difference of ± 0.0000001 gram per liter of H ions unbalanced by negative ions is about the point where bactericidal action begins. If the negative ions have been adsorbed by or have entered into combination with the media, the matter is serious, but if present in free form, much larger variations of H ion concentration are probably without effect.

The old method of titrating media, in which the medium is diluted to ten times its volume with water, must be very misleading, when the difference in dissociation in this dilute solution and in the medium itself is taken into consideration. In this respect the direct colorimetric determination is a great improvement.

It has always been a question with the writer whether it was the rational procedure to add large amounts of a strong alkali to media in the effort to make a slight change in the H-ion concentration. Is it not probable that this caustic causes a much more profound change in the nutrient qualities of the media, and consequently on the growth of the bacteria, than the difference in H-ion concentration which it is used to correct? Would it not be better, in the present state of our knowledge, merely to determine and to record the pH value of the media, and to use it as it is, without correction, provided it comes within a certain rather liberal range, and to reject it if it does not?

It is a difficult matter to determine the effect of pH of nutrient media on the growth of bacteria as found in water and sewage. For such experiments actual samples of contaminated water must be used, and not emulsions of bacteria grown in the incubator, which are comparable to hot-house plants as against weeds. As to media, it is not permissible to vary the pH for such experiments by adding acids or alkalis, since it is not known how this changes the nutrient or other properties of the media. If various media of different pH

values are used, it cannot be foretold in what other respects they may also differ, and with what effect on bacterial growth. In short, there are at the present time too many unknowns to be solved with one equation. Perhaps, some day a synthetic medium will be devised, which will make such determinations possible.

The writer sometimes wonders why we accept without question well-known brands of beef extract, peptone, agar and gelatin with no knowledge of the history of their source or manufacture. We know nothing definitely of the type or condition of animal or part thereof which is the source of the raw material, the temperatures and duration thereof, kinds or quantities of salts, etc., used in preparation, or age of the finished product when it reaches us. Looking on the preparation of media from the source of raw material to the agar tube as one process, we seem much concerned regarding the last tenth and very little about the previous nine-tenths. A study thereof and the formulation of standard methods for the manufacture of the ingredients entering into bacteriological media might eliminate some of the uncertainties which now exist.

Messrs. Bunker and Schuber are to be commended for the large amount of interesting and valuable data which they have presented in their article.

M. F. STEIN.³

MUNICIPAL WATER RATES⁵

This paper on Municipal Water Rates is entitled to be regarded as a valuable contribution to the literature of the water works field.

In dealing as it does, almost exclusively, with the rates of municipally owned water plants, it deals with a group of utilities whose rates seem, in a relatively large proportion of cases, to have been made with less careful consideration of the conditions and principles involved than is given to ratemaking for privately owned utilities by the more experienced state commissions, engineers, and others. The most inequitable and indefensible schedules of water rates are to be found among those of municipally owned plants. In some of these political considerations alone have seemed to govern in the determination of the existing rates. Quite likely some municipal water rate schedules now in effect are the outgrowth of the old and popular method of arriving at them by a consideration of those in use in other cities supposedly comparable and similar.

⁵ JOURNAL, September, 1921, page 497.

There is but little in the paper with which seriously to take issue, and there is not a great deal to be added to it, except by way of elaboration of points touched upon briefly.

The feature of the paper of special interest to the writer is the discussion of the service charge and the differences in views held by different persons as to the proper level for this element of the rate schedule, based, of course, upon the conditions existing in a specific case.

Here is an instance where there has seemed to be a wide range for what may be regarded, by different minds, as theoretically correct, this range resulting from the radically different reasoning applied. It is axiomatic that only correct reasoning can give a correct result.

From one point of view, much the greater part of the total cost of service of a water works should, theoretically, go into the service charges, since that part covers expenses or costs which are independent of the number of consumers on the books or the amount of water delivered. It covers, in addition to the customer or consumer expense, all of the interest charges, all of the taxes (where these are an item to be considered and are based upon property value rather than upon earnings), a good share of the annual depreciation allowance and even substantial parts of the various operating accounts. Such service charges would, were they practical of application, leave so little of the total to be collected as output expenses that the advantages of metered service would appear to be eliminated. Such reasoning leads to obviously faulty conclusions, hence it must be fundamentally erroneous. The error is in assuming as possible a condition which in practice never occurs to an extent sufficient to affect materially the results over an entire system, through any given period of time.

As the authors have well stated, "the consumers can be depended upon to continue their use of water, and, consequently, the money will continue to come over the counter in a fairly uniform stream from year to year." This, of course, refers to the consumers as a whole, and the condition is the result of something at least akin to what is known as the diversity factor. In most cities there will likely be instances of individual consumers suspending demands upon the utility for some weeks, perhaps months, at a time, without having been removed from the consumers' ledger or disconnected from the system. It is with reference to such cases that some have advocated the larger service charges whereby such customers would

at all times share in all costs which do not depend clearly and directly on the output of the plant.

It is the writer's belief that a fair and proper service charge is one which will cover, with a moderate margin, the customer costs of meter-reading, billing, and collecting, together with all expense and charges incident to meters and service pipes where these are not paid for outright and maintained by the consumer directly. This is apparently in accord with the views of the authors of the paper under discussion.

There appears to be a belief on the part of the authors that the "*total cost of service*" or "*total annual burden*" should not include interest charges on such portion of the total plant value as came from consumers. The common practice of omitting from the valuation or the rate base the interest and other charges on meters and house service pipes when these are paid for by individuals is in line with that idea. Has there not been some confusion and error in such practice? The meters in some cities, or in some instances, may be owned by consumers as distinguished from taxpayers, but this is probably not true as to the service connections, since they represent largely a labor cost and to that extent are inseparable from the taxpayer's property. They (service connections) remain property of the taxpayer regardless of whether they were paid for by him or by his tenant as a water consumer.

In the case of numerous municipal water plants the costs of main extensions are, at least in part, assessed against abutting property. From the standpoint of fundamental principles there should be no difference between the treatment, in rate-making cases, of the mains assessed against abutting property and the service connections financed in that manner. The only basis found for different treatment is in the fact that the service connections are for the benefit of individual properties exclusively, while there is a community interest in practically every foot of water main. By water main we mean pipe running longitudinally with the street.

The omission, from the rate base, or total annual burden, of annual charges against cost of service connections, on account of individual ownership thereof by taxpayers, does not introduce any inequities, apparently, between taxpayers and tenant consumers which cannot readily be cared for in another way, i.e., through the tenant's rental payments. The same statement will apply to the situation as to meters not owned by the water department, collectively.

Notwithstanding a reluctance on the part of the writer to trespass on the field of the legal fraternity by presuming to offer an authoritative opinion on a legal question, it is a temptation to remark that it seems quite doubtful that consumers (as distinguished from taxpayers) would have any legal rights in the matter of a claim for omission from the rate base of interest charges on property financed out of revenues obtained from them. The municipally owned water works, like any other public property of a community undoubtedly belongs to the taxpayers however obtained, subject, of course, to the prior claims of the holders of any outstanding bonds.

Referring to the statements, in the paper under discussion, appearing in the first paragraph on page 498, the point there made, if correctly understood, is one which the writer would question, primarily for reasons above given.

The first sentence of that paragraph as it stands, seems to exclude consideration of the great differences in operating costs of various municipal water plants as one of the opportunities for variations in municipal water rates, and yet, for the group of plants referred to, this element of the total burden varied in the ratio of 18 to 95. The statement as made would be rendered correct by insertion (end of line 1, page 498) of the words, "in part."

Reference to operating expenses recalls a matter which the writer has often felt should be given more attention than it has generally received in rate investigations. This is the matter of adjustments which should be made, both as to property value and operating costs, in these amounts as found.

A plant itself may represent either more or less capacity and cost, or value, than the then existing demands of good service require. If additions or improvements are needed at the time they should be indicated and provided, if possible, and the rates made to cover them. In certain cases wherein public service commissions have found an over-investment they have correspondingly reduced the rate of return used in their computations. Such cases do not, however, so far as the writer knows, include municipally owned water works.

The operating expenses should hardly be taken blindly, as they are found, as a basis for revision of rates, but should be critically examined to ascertain whether or not there is room for improvement in methods and efficiency or whether the wages and salaries of faithful and efficient employees are reasonably compensatory. Sometimes they are not so, and provision should be made for proper readjust-

ments, the amount of the changes, if any, being determined, of course, in conference with those in responsible charge of operation.

It is realized that some of the foregoing remarks have constituted something of a digression from the subject, although they were suggested by it. The general method outlined by the authors for distributing the various expenses in constructing a rate schedule is, so far as now seen, believed to be essentially correct.

W. E. MILLER.⁶

I am pleased to note the cordial discussion by Mr. Miller, indicating substantial agreement except on one point, and even this difference might have been avoided with some elaboration of the paragraph in question.

The writer fails to get clearly Mr. Miller's point of view with respect to service pipes and meters, where he states, in the ninth paragraph:

The common practice of omitting from the valuation or the rate base the interest and charges on meters and house service pipes when these are paid for by individuals is in line with that idea. Has there not been some confusion and error in such practice?

The practice of omitting such items from the *valuation* seems perfectly sound to the writer until such time as the city (or a water company) takes over the burden of maintaining such service line, admitting that any operating costs or maintenance actually paid out by the city, on service line and meter, should be returned either through the rates or by a direct charge for same.

We accept Mr. Miller's correction for line 1, page 498, as we had no intention of including operating expenses under the idea expressed in that paragraph. The thought of the writer, closely allied to this, and with respect to permissible "slide" in schedule, is expressed in more detail in a paper on "Water Rates for Industrial Consumers," presented to the Central States Section of the American Water Works Association, which will appear in a later issue of the JOURNAL.

The writer is in complete accord with Mr. Miller's statement that "Operating Expenses should not be taken blindly," and although slightly off the subject, I am tempted to state the converse, which has been heavily on my mind, that *a premium should be offered for efficient operation. There must be an incentive to induce efficient operation.* (This refers to commission control.)

⁶ Madison, Wisconsin.

The agreement of Mr. Miller with our "Proposed Method for Distribution of the Burden," we had expected, as well as the agreement of Mr. Hill on the "excess plant" idea, as voiced by him at the convention, for the key-note of the proposed method is in complete harmony with the principles, in this connection, stated in the committee report on "Private Fire Protection," for this Association appearing in the November issue of the JOURNAL for 1919, where Mr. Hill and Mr. Miller were the most active members on this committee. On page 731 of that report we find these words,

The capacity chargeable to the Capacity, or Demand, Cost is the surplus capacity of the system not apportioned for fire service.

and again on page 734,

The capacity costs are the costs chargeable to the excess plant made necessary to meet the contractual obligations of the company to furnish the maximum demand.

E. E. BANKSON.⁷

EXTENSION OF WATER MAINS⁸

The suggestion of Mr. Brush that a record of the practice and experience of different localities, in the matter of the extension of water mains, might be helpful to water works officials, leads the writer to offer the following.

The city of Portland, Oregon, includes within its boundaries an area of over 65 square miles, and had a population of 258,288 in 1920. It is using for its distribution system over 750 miles of mains of all sizes, 75 per cent of which are over 4 inches in diameter, and has had a varied experience in attempting to solve the problem of water main extensions in a rapidly growing city.

From the time the water supply of the city first came under the control of a publicly appointed water committee of fifteen members in 1887, until this committee was retired through a charter change in 1903, a period of sixteen years, all water main extensions for distribution purposes were paid for out of the net proceeds of water sold.

Under the Water Board of four members, appointed by the Mayor in 1903, as authorized by the new charter, the same policy was pursued for a number of years. Later, owing to the increased number

⁷ The J. N. Chester Engineers, Pittsburgh, Pa.

⁸ See JOURNAL, November, 1921, page 645.

of mains petitioned for by property owners in sparsely settled districts, very few mains were laid which upon investigation could not supply an increased number of water users sufficient to increase the department revenues by an amount equal to 6 per cent per annum upon estimated cost of the proposed main.

In 1911-1912 when the demand for new mains exceeded the ability of the department to finance them under the old plan the assessment plan was adopted. Under this plan the cost of mains to be laid was assessed against the property benefited, in the same manner as assessments for service are made and collected. With the difference, however, that whenever the revenue from a main so laid equalled 6 per cent per annum upon its assessed cost, the department refunded to the property owner the amount paid by him, as shown by the assessment record, less an allowance of 2.5 per cent per annum for depreciation for the time the main had been in use.

In no case did the assessment exceed the cost of an 8 inch cast iron main if laid in a residence district or a 12 inch cast iron main if laid in a business district. If the department decided that a larger main should be laid in any particular street in order to reinforce the supply for other mains in the same district, the excess cost was paid out of the general fund of the water department.

During this period the owners of several important additions in the outlying districts asked for a suitable design for distribution mains in the streets of their property. In compliance with this request plans for a gridiron system of cast iron mains were prepared by the department engineers and the mains were laid in accordance therewith. These mains are now being taken over by the department as fast as the mains in individual streets show a revenue equal to 6 per cent upon the estimated cost of same, less 2.5 per cent depreciation per annum.

Upon the adoption of the commission form of city government in 1913, another change was made. Water rates were reduced and the policy was adopted of selling bonds to defray cost of such extensions as had formerly been paid for out of the net proceeds of water sold. The assessment plan was continued, however, for such streets as were being improved with hard surface pavements before suitable cast iron mains had been laid or petitioned for.

The work was undertaken by the public works department under the city engineer, the water department assuming control of the mains after they were laid, and the cost of same is being refunded as in other cases.

During the years the city limits have been extended a number of times, to include several outlying additions having a considerable population supplied by private water companies, who had laid a system of several pipes and installed pumps to supply their customers from wells or springs. In some instances this expansion of boundaries was largely due to the desire of the inhabitants of the district to secure a supply of Bull Run water from city mains, for fire protection as well as domestic service. Eventually these small companies were absorbed by the water department and their mains purchased at the department engineers' appraised value as a part of the city's distribution system.

These pipes were largely of wrought iron or steel, less than 4 inches in diameter, and many of them were almost immediately replaced by cast iron pipes of adequate size, at the expense of the water fund.

The present situation is not regarded as ideal, at least in this respect. The Water Bureau receives no credit from other departments for water furnished for street cleaning or fire protection or other municipal purposes. The general property tax of the city contributing only the interest on one block of water bonds of \$1,250,000.00 sold in 1909-1910 under charter amendment of June, 1907.

Chief Engineer F. M. Randlett of the Water Bureau has for years been advocating a change in this respect, viz., that the Water Bureau should receive payment from other city departments, supported by general taxation, for the fair value of fire protection service, readiness to serve, and for water furnished for public use, and to this extent relieve the average householder or water user from the additional expense to which he is now subjected, but the council has so far failed to respond to this appeal.

D. D. CLARKE.⁹

JUDICIAL APPROVAL OF SERVICE CHARGE

Water works managers who are trying to put their rates on a more equitable basis for all classes of consumers by adopting a service charge may be interested to learn that the legality of such a charge has been established in Rhode Island by a decision of the Supreme Court of that state, Revelli v. Providence Gas Co., City Council of Cranston v. same, 115 Atl. 461. The service has been approved by many public utility commissions, but their rulings are incon-

⁹ Consulting Water Supply Engineer, Portland, Oregon.

clusive until the court of final jurisdiction of a state passes judgment on such charges, and up to date very few such court decisions have been made.

The Rhode Island case was a contest over the legality of a service charge of fifty cents per meter per month approved by the Rhode Island Public Utilities Commission. The appellants claimed such a charge violated a law of Rhode Island making it a misdemeanor punishable by a fine not exceeding \$500 to collect more money for gas than the meter shows has been used. The court ruled:

"The service charge is a uniform charge to all customers, which, together with another charge based upon the amount of gas consumed as shown by the meter, constitutes the entire amount to be paid. The service charge is an equal distribution of those burdens incident to the manufacture and distribution of gas which should be borne by all consumers, irrespective of the quantity used. The consumer of gas pays his equalized cost of the service, and neither the small consumer nor the large one is compelled to carry a load which should be shared by both."

The decision, properly used, can be made of real service in any attempt to introduce the service charge. Consumers in some cities have become so accustomed to the illogical single charge, whether a flat rate or a meter charge, that they will inevitably look upon the dual charge with suspicion, as an unknown, subtle means of wringing a few more cents from them. Where this opinion prevails, rulings by a public utility commission are unlikely to be convincing. A court of final jurisdiction, however, still retains its hold on popular respect, thank Heaven, and faith in its impartiality will make its decision favorable to the service charge a real help to those managers who are trying to serve their customers fairly.

JOHN M. GOODELL.¹⁰

PROGRAM FOR ANNUAL CONVENTION

The program for the annual Convention at Philadelphia is now being prepared. Suggestions regarding topics for discussion and particularly regarding papers on any phase of water supply are invited. Members are urged to send these suggestions at once to the Chairman of the Publication Committee, Robert B. Morse, Chief Engineer, Maryland State Department of Health, 16 West Saratoga Street, Baltimore, Md.

¹⁰ Hydraulic Engineer, 106 Lorraine Ave., Upper Montclair, N. J.